

WHAT IS CLAIMED IS:

- 1 1. An immersion lithographic system comprising:
  - 2 an optical surface;
  - 3 a wafer support for holding a workpiece; and
  - 4 an immersion fluid with a pH less than 7, disposed between the optical surface and the
  - 5 wafer support, said immersion fluid contacting at least a portion of the optical surface.
- 1 2. The system of claim 1 wherein the immersion fluid comprises water.
- 1 3. The system of claim 2 wherein the pH of said immersion fluid is in the range of 2 to 7.
- 1 4. The system of claim 3 wherein the pH of said immersion fluid is in the range of 4 to 7.
- 1 5. The system of claim 4 wherein the pH of said immersion fluid is in the range of 5 to 7.
- 1 6. The system of claim 5 wherein the pH of said immersion fluid is in the range of 6 to 7.
- 1 7. The system of claim 1 wherein the immersion fluid comprises hydrogen ions with a
  - 2 concentration in the range of  $10^{-7}$  to  $10^{-2}$  mole/L.
- 1 8. The system of claim 1 wherein the immersion fluid comprises hydrogen ions with a
  - 2 concentration in the range of  $10^{-7}$  to  $10^{-4}$  mole/L.
- 1 9. The system of claim 1 wherein the immersion fluid comprises hydrogen ions with a
  - 2 concentration in the range of  $10^{-7}$  to  $10^{-5}$  mole/L.

1    10.    The system of claim 1 wherein the immersion fluid comprises hydrogen ions with a  
2    concentration in the range of  $10^{-7}$  to  $10^{-6}$  mole/L.

1    11.    The system of claim 1 wherein the optical surface comprises silicon oxide.

1    12.    The system of claim 1 wherein the optical surface comprises fused silica.

1    13.    The system of claim 1 wherein the optical surface comprises calcium fluoride.

1    14.    The system of claim 13 further comprising a fluoride-containing compound dissolved in  
2    the immersion fluid.

1    15.    The system of claim 14 wherein the fluoride containing compound comprises at least one  
2    material selected from the group consisting of sodium fluoride, potassium fluoride, hydrogen  
3    fluoride, and combinations thereof.

1    16.    The system of claim 13 wherein the immersion fluid comprises fluoride ions with a  
2    concentration in the range of greater than 0.01 mole/L.

1    17.    The system of claim 16 wherein the immersion fluid comprises fluoride ions with a  
2    concentration in the range of greater than 0.05 mole/L.

1    18.    The system of claim 17 wherein the immersion fluid comprises fluoride ions with a  
2    concentration in the range of greater than 0.1 mole/L.

1    19.    The system of claim 1 further comprising a semiconductor structure on the wafer support  
2    structure, said semiconductor structure having a topmost photosensitive layer.

- 1    20.    The system of claim 19 wherein the photosensitive layer comprises a chemically
- 2    amplified photoresist.
  
- 1    21.    The system of claim 19 wherein the immersion fluid is in contact with a portion of the
- 2    photosensitive layer.
  
- 1    22.    The system of claim 19 wherein the semiconductor structure is immersed in the
- 2    immersion fluid.
  
- 1    23.    The system of claim 19 wherein the semiconductor structure comprises an integrated
- 2    circuit that includes transistors with a gate length not greater than 50 nm.
  
- 1    24.    The system of claim 19 wherein the wafer support is immersed in the immersion fluid.
  
- 1    25.    An immersion lithographic system for projecting light having a wavelength of less than
- 2    197 nm, the system comprising:
  - 3        an optical surface;
  - 4        water with a pH less than 7, said water contacting at least a portion of the optical surface;
  - 5        and
  - 6        a semiconductor structure having a topmost photoresist layer, a portion of said
  - 7        photoresist being in contact with the water.
  
- 1    26.    The system of claim 25 wherein the pH of the water is in the range of 2 to 7.
  
- 1    27.    The system of claim 26 wherein the pH of the water is in the range of 5 to 7.

- 1    28.    The system of claim 27 wherein the pH of the water is in the range of 6 to 7.
- 1    29.    The system of claim 25 wherein the optical surface comprises silicon oxide.
- 1    30.    The system of claim 25 wherein the optical surface comprises calcium fluoride.
- 1    31.    The system of claim 25 further comprising a fluoride containing compound dissolved in  
2    the water.
- 1    32.    The system of claim 31 wherein the fluoride containing compound comprises at least one  
2    material selected from the group consisting of sodium fluoride, potassium fluoride, hydrogen  
3    fluoride, and combinations thereof.
- 1    33.    The system of claim 25 wherein the water comprises fluoride ions with a concentration in  
2    the range of greater than 0.01 mole/L.
- 1    34.    The system of claim 25 wherein the photoresist layer comprises a chemically amplified  
2    photoresist.
- 1    35.    The system of claim 25 wherein the semiconductor structure is immersed in the water.
- 1    36.    The system of claim 25 further comprising a wafer support underlying the semiconductor  
2    structure.
- 1    37.    The system of claim 36 wherein the wafer support is immersed in the water.

1    38.    A method for illuminating a semiconductor structure having a topmost photoresist layer,  
2    comprising the steps of:

3                 introducing an immersion fluid into a space between an optical surface and the  
4    photoresist layer, said immersion fluid having a pH of less than 7; and

5                 directing optical energy through the immersion fluid and onto said photoresist layer.

1    39.    The method of claim 38 wherein the immersion fluid comprises water.

1    40.    The method of claim 38 wherein the pH of the immersion fluid is in the range of 2 to 7.

1    41.    The method of claim 40 wherein the pH of the immersion fluid is in the range of 4 to 7.

1    42.    The method of claim 41 wherein the pH of the immersion fluid is in the range of 5 to 7.

1    43.    The method of claim 42 wherein the pH of the immersion fluid is in the range of 6 to 7.

1    44.    The method of claim 38 wherein the immersion fluid comprises hydrogen ions with a  
2    concentration in the range of  $10^{-7}$  to  $10^{-2}$  mole/L.

1    45.    The method of claim 44 wherein the immersion fluid comprises hydrogen ions with a  
2    concentration in the range of  $10^{-7}$  to  $10^{-4}$  mole/L.

1    46.    The method of claim 45 wherein the immersion fluid comprises hydrogen ions with a  
2    concentration in the range of  $10^{-7}$  to  $10^{-5}$  mole/L.

1    47.    The method of claim 46 wherein the immersion fluid comprises hydrogen ions with a  
2    concentration in the range of  $10^{-7}$  to  $10^{-6}$  mole/L.

- 1    48.    The method of claim 38 wherein the optical surface comprises silicon oxide.
- 1    49.    The method of claim 38 wherein the optical surface comprises calcium fluoride.
- 1    50.    The method of claim 49 wherein the immersion fluid comprises water.
- 1    51.    The method of claim 50 further comprising a fluoride containing compound dissolved in  
2    the water.
- 1    52.    The method of claim 51 wherein the fluoride containing compound comprises a  
2    compound selected from the group consisting of sodium fluoride, potassium fluoride, hydrogen  
3    fluoride, or combinations thereof.
- 1    53.    The method of claim 49 wherein the immersion fluid comprises fluoride ions with a  
2    concentration in the range of greater than 0.01 mole/L.
- 1    54.    The method of claim 49 wherein the immersion fluid comprises fluoride ions with a  
2    concentration in the range of greater than 0.05 mole/L.
- 1    55.    The method of claim 49 wherein the immersion fluid comprises fluoride ions with a  
2    concentration in the range of greater than 0.1 mole/L.
- 1    56.    The method of claim 38 wherein the photoresist layer comprises a chemically amplified  
2    photoresist.
- 1    57.    The method of claim 38 wherein the immersion fluid is in contact with a portion of the  
2    photoresist layer.

1    58.    The method of claim 38 wherein the semiconductor structure is immersed in the  
2    immersion fluid.

1    59.    The method of claim 38 further comprising a wafer support underlying the semiconductor  
2    structure.

1    60.    The method of claim 59 wherein the wafer support is immersed in the immersion fluid.

1    61.    The method of claim 38 further comprising a step of developing the photoresist layer.

1    62.    The method of claim 61 wherein the step of developing the photoresist layer comprises  
2    immersing the photoresist in a tetramethylammonia hydroxide solution.

1    63.    A method for illuminating a semiconductor structure having a topmost photoresist layer,  
2    comprising the steps of:

3         introducing water into a space between an optical surface and the photoresist layer said  
4    water having a pH of less than 7; and

5         directing light with a wavelength of less than 450 nm through the water and onto said  
6    photoresist.

1    64.    The method of claim 63 wherein the pH of the water is in the range of 2 to 7.

1    65.    The method of claim 64 wherein the pH of the water is in the range of 5 to 7.

1    66.    The method of claim 65 wherein the pH of the water is in the range of 6 to 7.

1    67.    The method of claim 63 wherein the optical surface comprises silicon oxide.

- 1 68. The method of claim 63 wherein the optical surface comprises calcium fluoride.
- 1 69. The method of claim 63 further comprising a fluoride containing compound dissolved in
    - 2 the water.
- 1 70. The method of claim 69 wherein the fluoride containing compound comprises a
    - 2 compound selected from the group consisting of sodium fluoride, potassium fluoride, hydrogen
    - 3 fluoride, and combinations thereof.
- 1 71. The method of claim 63 wherein the water comprises fluoride ions with a concentration
    - 2 in the range of greater than 0.01 mole/L.
- 1 72. The method of claim 63 wherein the photoresist layer comprises a chemically amplified
    - 2 photoresist.
- 1 73. The method of claim 63 wherein the semiconductor structure is immersed in the water.
- 1 74. The method of claim 63 further comprising a wafer support underlying the semiconductor
    - 2 structure.
- 1 75. The method of claim 74 wherein the wafer support is immersed in the water.